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Feasibility analysis of GHG reduction target: Lessons from Taiwan's energy policy

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ABSTRACT

It is the opinion of this study that more than 10 years of the United Nations Framework Convention on Climate Change (UNFCCC) negotiations have been wasted on determining the greenhouse gas (GHG) emission targets. This study discussed two approaches of GHG reduction targets: top-down approach and bottom-up. This study criticized the top-down approach for reduction target determination has created a new problem for emission reduction efforts. Using Taiwan as a case study, this study adopted the GACMO model to decompose the energy policy and analyzed the cost effectiveness of various reduction strategies. Reviewing the emission reduction measures based on the bottom-up approach is the proper way to address GHG emission reductions. Thus, the countries should refocus on implementation of reduction strategies in the spirit of the UNFCCC. Finally, this study believes that if the reduction cost curves of each nation can be made, the Bali roadmap reached through the 2007 UNFCCC COP13/MOP3 in Bali, Indonesia, can be more defined and practical.

Contents

1. Introduction

Facing the threat of global climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 [1], followed in 1997 by the Kyoto Protocol, which has been in force since 2005. The Kyoto Protocol commits its 38 Annex I Parties and European Union (EU) to reduce their greenhouse gas (GHG) emissions to an average of 5.2% below the 1990 baseline levels between 2008 and 2012 (first commitment period), while assigning no GHG reduction obligations to developing countries such as China and India. Six greenhouse gases are included by the Kyoto Protocol, namely, CO_2, CH_4, N_2O,

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PFCs, HFCs, and SF_6 [2]. The current climate pact, the Kyoto Protocol, expires in 2012 and governments are scrambling to agree a new treaty, post-Kyoto climate regime.

Since 1992, the world has been through over 15 years of climate negotiations, but the global GHG emissions are in its highest growth rate ever recorded. This result is inconsistent with the claims that developed countries are determined to reduce their GHG emissions in order to mitigate the climate change effects [3]. The rapidly growing global GHG emissions present a challenge to the global emissions reduction efforts, and forced us to rethink what we have learned over the years of the Kyoto Protocol negotiations and implementation process. The setting of long-term GHG reduction target could be a problem.

The discussion of climate change issues was also initiated in Taiwan in 1992, and ever since the government has also announced multiple greenhouse gas emissions reduction measures, which cover economic incentives, command control and energy technology development. However, after more than 10 years of sometimes heated debate, the most controversial issue of setting GHG reduction target still has not been finalized.

2. Overview of GHG reduction targets

2.1. Top-down vs. bottom-up approaches

How should the GHG reduction target be determined for each country? Past researches have indicated that the discussions on GHG reduction targets have become much more diversified. Issues discussed during international negotiations included: long-term stabilizing levels for GHG in the atmosphere; modes of climate change mitigation commitments; reduction participants and timeframe; extents of reduction specifications; modes and participation of climate change mitigation; and equity of GHG reductions [4–7]. Even though many types of complex reduction targets have been proposed in these researches, they can basically be categorized into two approaches: top-down and bottom-up [8,9].

In the field of climate change research, the top-down approach determines reduction target based on scientific evidence. It starts with the global framework and long-term goal of stabilizing GHG concentrations and protecting the environment to determine a total GHG reduction amount, and then distributes the reduction amount among parties with reduction obligations. In essence, the top-down approach is a ‘‘what needs to be done’’ approach [8], which emphasizes environmental integrity. This approach was adopted by the Kyoto Protocol in determining the GHG reduction commitments for its Parties with commitments, and thus this approach may be called the Kyoto-style approach [9].

In contrast, the other approach for determining the GHG reduction target is the ‘‘bottom-up’’, which is basically a ‘‘what can be done approach’’ [8]. It starts with a fragmented framework, and then determines the reduction targets based on individual reduction technologies and economic impacts which can be tolerated. The entities committed to such reductions may be companies, individual country, regional alliance or international agreements [9]. Examples for this approach are the determination of national policies and measures.

Past researches have recommended that Annex I Parties of UNFCCC should continue to adopt the Kyoto-style quantitative commitments with absolute reductions, while major developing countries not regulated by the Kyoto Protocol may adopt the policies and measures approach to fulfill their shares of emission reductions [6,7].

2.2. Critical aspects of history

Since 1992, the top-down approach has been the mainstream in international climate change negotiations and academic research [8]. Therefore, forming GHG reduction modes through top-down approach has been widely adopted by national governments, international organizations or the private sector. This research observed that since the adoption of UNFCCC in 1992, the top-down approach used in determining reduction target is not only unhelpful in solving climate change, but can actually create new problems. For example:

- First example: In the 1992 adopted UNFCCC, the original goal is to reduce parties with commitments’ GHG emissions to 1990 levels in 2000 [1]. However, this goal became unattainable as the negotiations dragged on. In the Kyoto Protocol adopted in 1997, the original goal has been changed to achieve a GHG reduction of 5.2% below 1990 levels between 2008 and 2012 [2]. That is a target date of 12 years behind the original date.
- Second example: In March 2007, the EU committed 20% GHG reduction below 1990 levels in 2020, and pledged that if other major industrialized countries agree with its global package, it will increase its reductions to 30% [9,10]. Moreover, in the 2007 conference of the parties to UNFCCC (COP13/MOP3 in Bali), the EU argued another ambitious reduction target of 25–40% (compared with 1990 levels) in 2020 for major industrialized countries based on the latest the Intergovernmental Panel on Climate Change (IPCC) assessment reports [11]. In the July 2008 G8 Summit, all leaders, including the EU, pledged a new goal of achieving at least 50% reduction of global GHG emissions by 2050 [12]. However, the EU’s leader altered GHG reduction targets at a summit on December 2008. By the year 2020, the EU promised three targets, including: to cut overall greenhouse gas emissions by 20% over 1990 levels; to obtain 20% of overall energy from renewable energy; and to make efficiency savings of 20% over forecast consumption [13]. The EU was watering down its previous commitments to urgently tackle climate change through deep cuts in GHG emissions. European industry felt too much was being asked of new deal, while green groups thought industry had gained rather too many concessions [13]. Some environmental scientists thought the EU backtracked on their commitments [11,14]. In addition, the EU also raised the amount of emissions member countries could offset by investing projects in developing countries. Some studies estimated that EU’s actual GHG emissions reductions would come down from 20% to a mere 4% [11,14].
- Third example: It has long been rumored that Canada will withdraw from the Kyoto Protocol. Canada’s Minister of Environment has denied the rumor, but environmental groups treated this denial as ‘‘patently dishonest’’ [15]. In reality, Canada suggested that meeting the Kyoto target could cost every Canadian $3,500 per year for the next several years and that taking domestic reduction actions alone will not enough for Canada to achieve its Kyoto commitment [16]. Many parties, like Canada, to the Kyoto Protocol are struggling to meet their targets because it too costly to comply.

Judging from these examples, this study pointed out that there are several deficiencies associated with determining reduction target through the top-down approach, including: difficulties in negotiations; difficulties in compliance; difficulties in expanding participation and high reduction cost, etc. These historical events above may make people wonder that if all this is just a political maneuvering instead of true pursuit of environmental protection. In fact, the Kyoto Protocol does not contain stringent compliance regime or any economical penalties for non-compliance. If one

party insists on not implementing those obligations under the Kyoto Protocol, there will be no heavy penalty and consequence.

Moreover, as the GHG reduction target determined through the top-down approach was built on "a relatively long period of time" [9], the politicians have thus acquired more space and time for maneuvering. It seems like that the timeframe to achieve real GHG reductions has been extended for several decades. As a result, more and more countries vowed to halve greenhouse emissions by 2050. However, no present politicians will still be in power in 2050; yet their present rhetoric will affect the environment of the generations to come. We really need to rethink what we have learned over years of the Kyoto Protocol negotiations. This is the time for us to rethink the setting of the GHG reduction target from another approach, bottom-up.

3. The case of Taiwan

Even though Taiwan has no commitment under the Kyoto Protocol, its annual energy-related carbon dioxide (CO_2) emissions have been on an increasing trend for decades and currently take up about 1% of such emissions globally [17]. It is only natural that Taiwan is facing increasing domestic and international pressure to reduce GHG emissions, as its emissions are already on scale or even exceed that of some Annex I Parties. Many past researches have called on Taiwan's government to accelerate its efforts in GHG reduction [18–20]. In response, the Executive Yuan (the Cabinet) established an inter-ministerial task force in 1992 to study how to cope with the climate change issue in Taiwan.

3.1. Taiwan's economic status

After World War II, economic development of Taiwan has gone through the four stages of agriculture, light industry, heavy industry and high-tech industry. As a result, Taiwan has earned itself the reputation of economic miracle and became one of the four East Asian Dragons. In recent years, the pace of Taiwan's industrial development has gradually slowed down, with the industrial structure tilted toward semiconductor and communications industries, as well as increasing expansion of the service sector. During the 20-year period from 1985 to 2005, with the exception of negative GDP growth in 2001 (−2.17%), Taiwan's annual GDP growth rates ranged from 3.43% to 12.6% [21]. In order to maintain the momentum of economic growth, Taiwan relies on copious amount of energy supply. As seen in Fig. 1, even though Taiwan's population growth rate has slowed down gradually during the 1990–2005 period, GDP and energy consumption have more than doubled during this period. This phenomenon prompted this research, which subsequently concluded that GDP and energy consumption are highly correlated for Taiwan's economy.

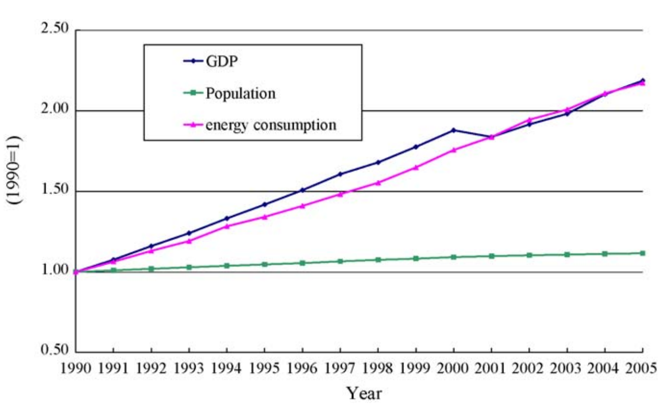

Fig. 1. Taiwan's GDP, energy consumption and population growth during the period of 1990–2005.

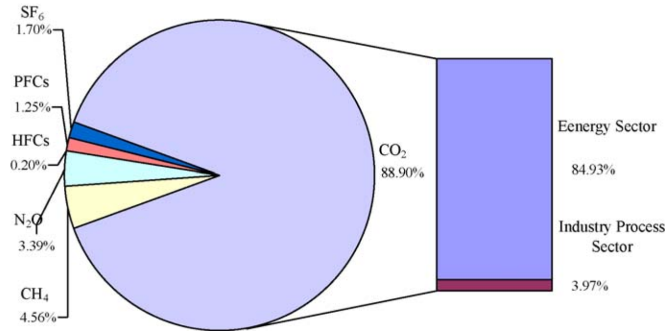

Fig. 2. Taiwan's greenhouse gas emissions structure in 2005.

3.2. Taiwan's GHG inventory

Taiwan Environmental Protection Administration's (TEPA) statistics showed that in 2005, Taiwan emitted a total of 305,476 thousand tons carbon dioxide equivalent (Gg CO_2-eq) of greenhouse gases, excluding the land-use change and forestry (LUCF) absorption amount (Fig. 2) [22]. Emissions by the energy sector (including carbon dioxide, methane and nitrous oxide) totaled 263,124 Gg CO_2-eq, accounting for 86.14% of total emissions. Of the six greenhouse gases, carbon dioxide emissions from energy generation have taken up the largest portion over the years.

Statistics published by the International Energy Agency also indicated that Taiwan emitted 255 million tons carbon dioxide in 2005, which ranked 22nd in the world [17]. However, Taiwan's emissions in 2005 increased 124% when compared with 1990 emissions, which is much higher than the increase rate for OECD members and the global total emissions (17% and 28%, respectively) (Table 1).

For the purpose of evaluating the carbon dioxide emission scenario for the energy sector, the Bureau of Energy, the Ministry of Economic Affairs (MOEA), adopted the following emission assumptions for the period of 2006–2025: GDP growth rate average 4.67–3.71%; the population growth rate at 0.35–0.12%; the service sector continues to expand, and in 2025, the ratios for agriculture, industry and service sector stand at 2%, 30% and 68%, respectively [23]. Based on these assumptions, Taiwan's carbon dioxide emissions of the BAU scenario will reach 531 million tons in 2025, and 616 million tons in 2030 (Table 2).

Table 1
Taiwan's energy/economy/environmental indicators in 2005.

	Taiwan	World	OECD	Taiwan in the world	
				Rank	%
Total emissions[a] (million tons CO_2)	255.42	26,583	12,911	22	0.96
Per capita emission (tons CO_2/capita)	11.26	4.18	11.09	18	–
Population (million)	22.69	6,352	1,164	45	0.36
GDP[b] (billion USD)	484.21	52,289	29,493	18	0.93
Per capita GDP[b] (thousand USD)	21.34	8.23	25.34	27	–
Energy supply (MTOE)	104.24	11,223	5,508	21	0.93
Per capita consumption (TOE)	4.95	1.77	4.73	22	–
CO_2 emissions/GDP[b] (kg CO_2/USD)	0.53	0.51	0.44	47	–

[a] Not including international aviation CO_2 emissions.
[b] Based on purchase power parity and USD (2000 value).

Table 2
Primary assumption parameters and CO_2 emissions in BAU scenario.

	2000	2010	2020	2030	Annual increase (%)		
					2000–2010	2010–2020	2020–2030
GDP (1991 trillion NT$)	88.8	131.8	194.3	272.6	4.84	4.74	4.02
Population (million)	22.3	23.2	23.6	23.3	0.40	0.17	−0.01
Household size (persons)	3.3	2.9	2.6	2.4	−1.21	−1.03	−0.77
CO_2 emissions (million tons)	221	329	463	616	48.86	40.72	33.05

Judging from the structure of GHG inventory and the project of CO_2 emissions, there is no doubt that the major focus of Taiwan's GHG emission reduction strategy should be on the reduction of carbon dioxide emissions from fossil fuel combustion processes. Carbon dioxide emissions contributed not only the largest portion of Taiwan's greenhouse gas emissions, but also pushed Taiwan's emissions close to the top 20 among global economies. The large amount of carbon dioxide emissions is the main reason why Taiwan is under both domestic and international pressure to reduce its greenhouse gas emissions.

3.3. Taiwan's energy policy

Taiwan is a densely populated island with only limited natural resources. Energy plays a vital role in national economic development. Of the energy supply for Taiwan in 2005, indigenous production only took up 1.8%, with the rest being imported energy (98.12%) [23].

The first version of ''The Energy Policy of the Taiwan'' was approved by the Executive Yuan and promulgated in April 1973. Afterwards, in response to the impact of energy crises and changes in the energy situation, the energy policy was revised four times in 1979, 1984, 1990 and 1996. Afterward, Two National Energy Conferences (NEC) were convened in Taipei on May 26th and 27th, 1998 and June 20th and 21st, 2005, for the purposes of formulating strategies and measures in response to the impact of the UNFCCC and to seek a balance among economic development, energy supply, and environmental protection in Taiwan. The aims of Taiwan's energy policy are to establish a liberalized, efficient, and clean energy supply and demand system based on the environment protection requirements. Future energy policy, in response to the UNFCCC, includes the following key tasks [23]:

- Coordinating the development of 3E (energy, environment, economy).
- Stabilizing energy supply to increase energy independence.
- Increasing energy efficiency and reinforcing management of energy efficiency.
- Further promoting liberalization of the energy market.
- Reinforcing research and development.
- Promoting education campaigns and expanding public participation.

There were many CO_2 reduction strategies and measures proposed for the energy sector during the 2005 National Energy Conference [24,25], called the ''2005 Energy Policy''. Due to discussing the feasibility of the setting GHG reduction targets, we would not like to explain each policy and measure in detail.

On the supply side, several strategies and measures were also adopted, including: installed power generation from renewable energy sources to reach 5130 MW in 2010 and 700–800 MW in 2020 and 800–900 MW in 2025; expand the use of natural gas to reach 13 million tons in 2010, 16–20 million tons in 2020 and 20–22 million tons in 2025; expand the use of bio-diesel and bio-ethanol [26–28].

The strategies on the demand side included: textile industry energy management, cement industry energy management, energy saving through equipment modification for the petro-chemical, transportation, cement, synthetic fiber, iron and steel, paper industries, and energy savings of the service sector [23]. The goal is to improve energy efficiency by more than 2% per annum, so that when compared with the level in 2005, energy intensity will decrease 20% by 2015. Supplemented by further technological breakthroughs and proper administrative measures, energy intensity will decrease 50% by 2025.

3.4. Taiwan's CO_2 reduction target dilemma

There are three official proposals for CO_2 reduction target drafted by the Taiwan government since 1998 to now. After the adoption of the Kyoto Protocol in 1997, the Taiwan government drafted a top-down GHG reduction target in the 1998 National Energy Conference. The government would reduce CO_2 emissions from fuel combustion to 2000 levels before 2020 (called the 1998 proposal). The major reduction strategy was the expansion of nuclear power generation capacity. However with the announcement of the Nuclear-Free Homeland policy in 2001 and the continuing growth of GHG emissions, this target was under serious challenge and review.

With the entry into force of the Kyoto Protocol in 2005, the government held its second National Energy Conference and reviewed the results of past emission reduction efforts. Because of some suggestions from experts, the government subsequently proposed a bottom-up target which is to reduce the emissions in 2025–2030 by 30% below the BAU scenario (called the 2005 proposal). At this stage, the expansion of nuclear power generation has been completely ruled out and that the policy for renewable energy promotion, energy efficiency improvement and energy pricing adjustment were adopted instead. However, those strategies, also mostly made from the top-down perspective, are focusing on electricity and gasoline pricing adjustment and carbon tax. These measures involving changes of human lifestyle and habits are very difficult to evaluate their reduction effectiveness. It was found that there is high uncertainty in achieving this GHG reduction target, due to lack of policy evaluation and cost analysis.

In 2008, under the pressure of international trend and request of environmental protection groups, the government again pondered the top-down reduction target and proposed to reduce the carbon dioxide emissions to its 2008 level between 2016 and 2020, and further reduce to the 2000 level in 2025 (or called the 2008 proposal).

Now, Taiwan's wavering between top-down and bottom-up reduction target is a reflection of the global attitude toward climate change issues (Fig. 3). The ambiguity of international convention created the uncertainty in government decision making, and has thus influenced the global community for more than a decade. With the slow progress of the post-Kyoto negotiations, this trend is expected to continue and will subject Taiwan as well as other developing countries to more dilemmas in pursuing GHG reductions.

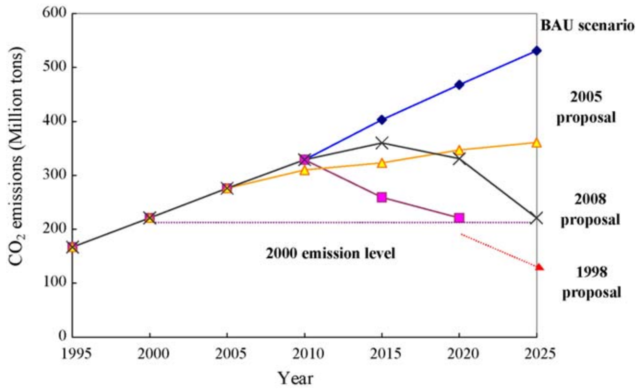

Fig. 3. Three proposals of CO_2 reduction target diagram.

4. Methodology and approach

Since the 2005 Energy Policy announced by Taiwan is of the latest information and the measures are currently being implemented, this study decomposed those measures and policies to evaluate the reduction costs and the feasibility of GHG reduction targets.

In the past, too many research organizations adopted complex mathematical models to analyze GHG reduction targets. However, few developing countries can afford the financial or human resources for such a complex mathematical model or database, and the result is the lack of equivalent dialog channel between the developed and developing countries. In order to recheck GHG reduction targets, this study adopted the simple tool to decompose the energy policy and analyzed the cost effectiveness of various reduction strategies. Therefore, the GACMO (Greenhouse Gas Costing Model) was selected for use in this study.

GACMO is a GHG emission reduction strategy evaluation model developed by the UNEP Centre for Energy and Environment (UCCEE), and has been used for country studies in Botswana, Zambia, Peru, Colombia, Denmark etc. [29]. Being a spreadsheet tool, GACMO can be used to rank the cost effectiveness of various GHG reduction strategies in a transparent and simple way, even when there is no detailed data available. GACMO adopted the principle of calculating the reduction costs when individual reduction strategies replace the high emission technologies under the same comparative basis (same power generation capacity/power generation, single plant/residence, passenger-kilometer), aggregate and rank the average cost of each emission reduction option, and then draw the reduction cost curve. The cumulative GHG reduction from successive mitigation options (ton CO_2 avoided) can be plotted against the cost per unit of GHG reduction (\$/ton CO_2); in the figure, the area under the cost curve yields the total GHG reduction cost.

As using the GACMO model, consideration should be given to interdependencies among options, for example, benefits such as fuel switching in the electric sector may be reduced by end-use efficiency programs. In Taiwan, the various measures for GHG reduction were proposed separately by the respective competent authorities without considering their inter-relationship. Therefore, GACMO is suitable for evaluating project-based reduction costs.

In addition, this study considered the costs of equipment, fuels, and operation and maintenance for the various reduction measures as shown in Eq. (1) below [30]:

$$\text{Reduction cost} = ((C_A + C_{MA} + F_A)) - (C_R + C_{MR} + F_R))/(E_R - E_A) \quad (1)$$

where C_A = average (or levelized) investment for abatement option; C_{MA} = abatement option operation and maintenance; C_R = average (or levelized) investment for reference option; C_{MR} = reference option operating and maintenance costs; F_A = abatement option fuel costs; F_R = reference option fuel costs; E_R = reference option emission; E_A = abatement option emission.

The calculation results from GACMO usually include 'negative cost'. The negative cost results (or no-regret measures) are measures for which benefits (i.e. energy cost savings) exceed costs [31,32].

Of course, the uncertainties related to these long-term calculations are huge. No attempt is being made to establish total integrated cost curves covering all Taiwan's GHG reduction strategies in this study. A few limitations have to be stated, including:

- This research only evaluated measures which clearly mirror the baseline scenario and have the goal of reducing CO_2 emissions, and adopted the discount rate of 5%.
- There are no imposition of carbon taxes and changes of human lifestyle and habits in this study.
- This research did not study the interaction of the energy system and other economical systems.
- There is no change in the level of energy service demand when the new technology is introduced.

5. Results

5.1. Reduction cost and potential

In 2010, the reduction costs range from −NT\$12/ton CO_2 to NT\$1,725/ton CO_2, with the highest cost being the increased use of LNG (see Fig. 4). The petrochemical industry's equipment

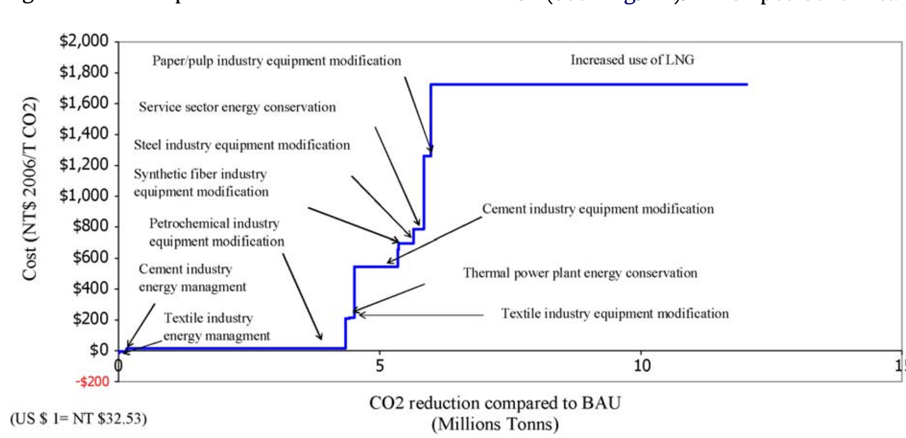

Fig. 4. Carbon dioxide emission reduction costs and potentials compared to BAU scenario in 2010.

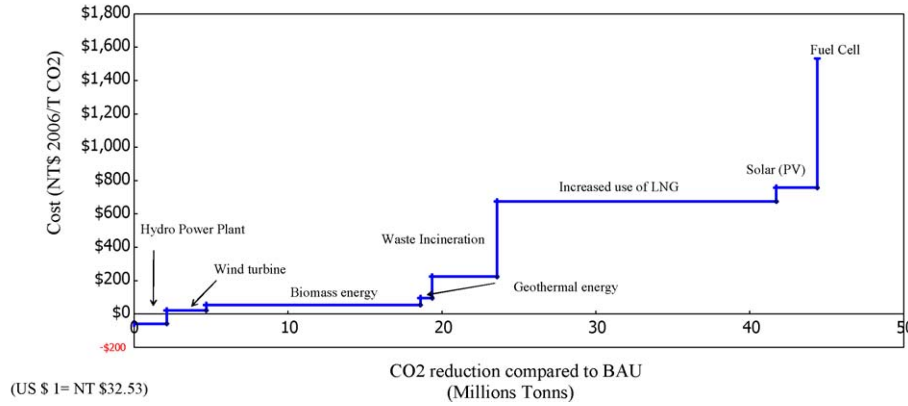

Fig. 5. Carbon dioxide emission reduction costs and potentials compared to BAU scenario in 2030.

modification measures have the highest emission reduction potential at 4.19 million tons. For this period, the major emission reduction measures are demand side management measures such as energy conservation and energy efficiency improvements, and the total emission reduction potential is only 12.03 million tons.

In 2030, the reduction costs range from −NT$59/ton CO_2 to NT$1,532/ton CO_2, with the highest cost being fuel cell (see Fig. 5). The increased use of LNG measure still has the highest emission reduction potential at 18.14 million tons. For this period, the major emission reduction measures remained as the changes in supply side power generation, but the total emission reduction potential is increased to 46.05 million tons.

The results show approximately 10% CO_2 emissions reduction compared to the BAU scenario in 2030. Such result seems quite distant from the commitment by the government. It is not surprising that only a little CO_2 reduction can be expected. From a technical perspective, without more clear policies and measures, it would be difficult to achieve the target of "the 2005 proposal" with the existing policies, let alone the top-down target proposed in 1998 and 2008, respectively. Therefore, it is the opinion of this study that the policies should be very clear with a more detailed reduction timeline.

5.2. Lessons from Taiwan's energy policy

Because of spending a lot of time in setting GHG reduction targets, the government did not review in detail all possible emission reduction measures. Based on the results, it seems that there are relatively limited measures and actions that can be taken by the government to achieve the long-term reduction target. In addition, some lessons from this evaluation are as follows:

- Very few no regret measures exist. From the perspective of emission reduction costs, there are very few negative cost measures proposed for 2010 and 2030.
- The expected reduction from energy conservation efforts lack detailed policy planning, and therefore it cannot be assessed by the model. These programs and measures were proposed by different governmental departments and thus quite diversified. Because of different base years and policy aims, it is quite difficult to make the determination of reduction results from these measures.
- Due to their lack of cost and technical details, the reduction strategies in residential/commercial and transportation sectors are almost excluded from consideration, for example, green buildings, elevated electricity tariff, promotion of building energy saving services (ESCO), construction of high-speed railway, mass transportation system, and reducing usage of motor vehicles, etc. However, these are wishful-thinking plans with no specific aims; in other words, no considerable amount of budget has been allocated.
- There are inherent limitations with adopting the spreadsheet model in evaluating Taiwan's energy policy. In order to make up for the deficiencies of this model, it is necessary to conduct evaluation using a model that is more complete and can better match the overall economic activities. The results of this research are to construct basic blueprint that can be used as reference for future evaluation of integrated energy system model.

Actually, climate change is a long-term policy challenge. Judging from this study, the fragmentation of domestic politics and the dispute of long-term international negotiation aggravate this challenge. In order not to let the growing GHG reduction efforts become just empty talks, it is necessary to establish a domestic legal regime to regulate governmental mitigation efforts. Thus, Taiwan Environmental Protection Administration has drafted the Greenhouse Gas Reduction Bill in 2006, which was submitted to the Congress for deliberation. Jointly developed by the government and the private sector, the Act establishes a framework to regulate GHG emissions based on emission efficiencies and new-source emissions, as well as penalties for non-compliance. In addition, the cap and trade concept were adopted in the Bill. If the Bill passed, further CO_2 reduction will be expected.

6. Discussion

6.1. Turning top-down into bottom-up

The 2007 UNFCCC COP13/MOP3 in Bali culminated in the adoption of the Bali roadmap, which charts the course for a new negotiating process to be concluded by 2009 that will ultimately lead to a post-Kyoto international agreement on climate change [33]. This is a time to make the Bali roadmap more practical.

Increasingly more organizations are advocating the adoption of sector-based or bottom-up approach as the basis for post-Kyoto negotiations [34,35]. When developing national reduction strategies, it might be important to prioritize among different possible reduction options [36]. Nonetheless, past studies rarely mentioned what tools should be used as basis for evaluation or open discussion. This study thus adopted the GACMO model to clearly delineate the effects of national GHG reduction strategies and average costs for technology and fuel inputs. For most developing countries without abundant database, this approach will be more convenient for evaluation and planning.

If each country is willing to share their reduction cost curves for various emissions reduction technologies, divide their promotion strategies into short, medium and long-term period, and then adopt the UNFCCC in-depth review mode for National Communication, the emission reduction aspirations can be more easily turned into actions and help mitigate climate change impacts. At present, this study believes that if the reduction cost curves of each nation can be made, the Bali roadmap can be more defined and practical.

As every country has the responsibility to reduce GHG emissions, it may be better to adopt the reduction targets based on the bottom-up approach. In other words, the reduction targets may be established based on the cost-effectiveness combination, so that they are in line with the spirits of the UNFCCC [37].

6.2. Rhetoric or action

Mitigation of climate change has suddenly become the most concerned global environmental issue of today. As most scientific researches have indicated that we should strengthen our GHG reduction efforts, and this trend has resulted in pressure to politicians around the globe. Many politicians may not fully understand the true meaning of climate change, the types of GHG emissions or the problems associated with mitigation technologies or economic impacts, yet they are often forced to announce unrealistic GHG reduction targets due to the pressure of this global environmental trend. In almost any political summits lately, you will hear politicians describing the global climate change situation as "urgent", "vital" or even "imperative"; in reality nothing has actually been committed or performed [38].

The truth is, the setting of long-term GHG reduction targets has become a demonstration of political determinations. However, the present-day politicians will be long gone when the long-term targets are due and will thus not be held accountable; however, the environmental illness will be long with us even after all the present politicians are gone.

The social psychology often discusses the "conformity" between the "group" and the "individuals". Here the "conformity" means that when facing group pressure and incorrect information, the individuals will often adopt behavior and thoughts consistent with the majority [39,40], which is also known as the "majority effect", a common mistake by most of us. Now, this climate change problem may be called the "new conformity phenomenon". Nonetheless, through such reckless actions, many such politicians have gained praises from the crowd, obtained political gains and also created many copy-cat politicians. In the past, there does not appear to be research conducted on the relationship between climate change and conformity. This comparison may not be rock-solid, but it is not the purpose of this research, as this research is focused on the impacts from the politicians' conformity. This phenomenon is alarming, as what really lies behind the seemingly slogan chanting conformity, may be the endless sufferings of our future generations.

7. Conclusion

From analysis of the history of international negotiations and the case of Taiwan, top-down target does not seem feasible without clear technical considerations. In addition, the GACMO model is a good method to assess a country's reduction strategies and the feasibility of its commitment. The use of the bottom-up approach GACMO model to evaluate the various emission reduction measures proposed by the individual government departments/agencies may help to establish reduction costs and potentials for different time-frames. This can be beneficial to decision makers in reviewing the cost effectiveness of each policy, as well as re-evaluating the various measures. Also, the use of a model commonly adopted by the international community will be helpful to conduct international comparison.

The top-down approach used in determining GHG reduction target has created new problems. It is the opinion of this research that even though the scope of the GHG reduction targets should be global, they should be implemented on a country level; therefore the approach used for determining such targets should be bottom-up, not top-down. The timeframe for the reduction targets should cover short-term, mid-term and long-term, and different reduction efforts should be adopted for different timeframe. In terms of entities responsible for carrying out reduction and the reduction strategies, cost effectiveness should be the major consideration.

For GHG reduction to succeed, GHG reduction targets must be practical and deals meaningful. In a word, in order to address this global issue, we need to pursue collective action and turn rhetoric into reality.

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